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JC915 U.S. PTO
10/10/00

ORIGINAL/CIP PATENT APPLICATION TRANSMITTAL LETTER

ATTORNEY'S DOCKET NO.
RD-27,502/USA

TO THE ASSISTANT COMMISSIONER FOR PATENTS:

Transmitted herewith for filing is the ☒ ORIGINAL ☐ CONTINUATION-IN-PART patent application of:

Christopher Anthony Kaminski, Robert John Nygard, and Yu -NMN- Wang

Inventor(s)

JC944 U.S. PTO
09/684485
10/10/00

For EXPANDABLE FLAT WINDING FOR ROTATING ELECTRIC MACHINE FIELDS

(Title of Invention)

☐ This is a Continuation-In-Part of Serial No. _____, filed _____, Attorney Docket No. _____.

ENCLOSED ARE:

☒ Specification having 7 total pages.

☒ 3 sheets of ☐ formal ☒ informal drawings.

☒ Declaration. ☐ Unsigned Declaration.

☐ Information Disclosure Statement.

☐ Other _____

☒ An Assignment of the invention to General Electric Company with cover sheet.

The filing fee is calculated below:

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INDEPENDENT CLAIMS	3 - 3 =	0	x $80.00	$0.00
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Oct. 4, 2000
date

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EXPANDABLE FLAT WINDING FOR ROTATING ELECTRIC MACHINE FIELDS

This application claims the benefit of U.S. Provisional Patent Application Serial No. 60/169,242, filed December 6, 1999, the entire content of which is herein incorporated by reference.

BACKGROUND OF THE INVENTION

This invention relates to rotational electric machines and, more particularly, to a multi-piece two-pole machine rotor including either flat windings or superconductive windings for machine fields.

In electric machines having a rotor and a stator, the rotor is provided with field windings, and the stator is provided with armature windings. The rotor is typically provided with rotor spindles to effect rotation. With this structure, however, the spindles on each end of the rotor body require the ends of the field winding, or end arms, to be formed into an arc concentric with the spindle. This rotor construction including a one-piece rotor forging and end winding modules having curved ends is described in co-pending U.S. Patent Application Serial No. 09/491,504, filed January 26, 2000 and assigned to the instant assignee.

It would be desirable to flatten the winding construction of the prior end winding modules and eliminate the arcs required for concentricity with the spindle. A flattened winding construction is described in co-pending U.S. Patent Application Serial No. 09/590,176 (GE Docket RD-27,503/USA), filed June 9, 2000. Flat windings with straight end turns extending diametrically across the rotor, however, are susceptible to elongation under the pull of centrifugal forces. The introduction of a preloaded axial offset can allow the end arms to lengthen and shorten with changes in rotor speed, without suffering elongation. On the other hand, each of the unsupported end arms will be subject to minimum induced centrifugal forces and effect support from the straight sections of the winding.

BRIEF SUMMARY OF THE INVENTION

In an exemplary embodiment of the invention, a winding module for a rotor includes at least one flat winding that is angled at an end turn, wherein a vertex of the angled end turn is aligned with an axis of rotation. The winding module may include a plurality of flat windings and blocks disposed between the windings.

In another exemplary embodiment of the invention, a rotor includes a rotor body defining pole faces and having parallel sides adjacent the pole faces. A winding module is fitted over the parallel sides of the rotor body and includes at least one flat winding that is angled at an end turn. A vertex of the angled end turn is aligned with an axis of rotation. A pair of spindles is secured to respective ends of the rotor body, wherein the spindles secure ends of the winding module to the rotor body.

In still another exemplary embodiment of the invention, a rotor winding module for generator fields includes at least one flat winding shaped to include a preloaded axial offset that allows end arms to lengthen and shorten with changes in rotor speed.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 illustrates a machine rotor assembly including a one-piece rotor forging and end winding modules with curved ends;

FIGURE 2 illustrates a flat winding component of the invention;

FIGURE 3 illustrates an example of a three-coil winding component of the invention; and

FIGURE 4 is an assembly drawing of a generator rotor accommodating the flat windings of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The rotor assembly of the noted co-pending U.S. Patent Application Serial No. 09/590,176 is shown in FIGURE 1. The assembly includes a multi-pole magnetic core 32 (two-pole core shown) having spindles 33 and receiving a plurality of winding assemblies 34, one for each pole. Corresponding pole faces 36 are formed at ends of the rotor forging. As shown, winding assemblies 34 are slid over the parallel sided forging of two-pole magnetic core 32. Winding assemblies 34 are curved into an arc concentric with spindles 33 to accommodate the spindles. It is desirable, however, to flatten the winding construction for simplicity and to reduce associated manufacturing and assembly costs

FIGURE 4 is an assembly drawing of a preferred embodiment of the rotor of the invention. As shown, the rotor forging is divided into at least three pieces including a rotor body 12 and a pair of generally tuning fork-shaped spindles 14. The so-shaped spindles 14 define notches 16 therein. A winding module 18 includes a plurality of flat field windings stacked to form openings 20 therein that are sized to fit over rotor body 12. The windings are stacked using standard layered winding methods. As shown, the flat field windings of winding module 18 have a smaller perimeter at outside ends of the winding module, tapering toward a largest perimeter at the middle of the winding module. The flat windings may comprise copper windings or superconductive windings.

FIGURE 2 illustrates a flat winding component or coil 19 of winding module 18 of FIGURE 4. Winding component 19 includes a shallow angle 19A in each end turn and a vertex 19B that is aligned to be coplanar with an axis of rotation 21 of the rotor field. Angle 19A in each end turn introduces a preloaded axial offset that allows the end arms to lengthen and shorten radially with changes in rotor speed, without actually undergoing elongation. Such a construction serves to minimize the winding stresses in different operating conditions.

FIGURE 3 illustrates an example of a three-component winding with optional end winding blocking in the axial direction. Blocks 22 are inserted between

winding components or coils 19 along an axis of symmetry, filling the space between rotor body 12 and brace portion 26 bridging legs 28 of spindles 14. A spring 24 is inserted between each spindle 14 and the outermost one of blocks 22 as shown. Spring 24 maintains compression in the blocks as the axial arms of the winding expand with acceleration of the rotor to running speed.

Winding module 18 is fitted over the parallel sides of rotor body 12 with spindles 14 separated from rotor body 12. Once in place, spindles 14 are secured to the rotor body by screws 23 or the like. Notch 16 in the spindles is sized to receive ends 18A of winding module 18. After fitting the winding module over the parallel sides of rotor body 12, spindles 14 are secured to the rotor body by screws 23, and the outside surfaces 30 of the spindles are substantially flush with the corresponding surfaces of rotor body 12.

While only certain preferred features of the invention have been illustrated and described, many modifications and changes will occur to those skilled in the art. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit of the invention.

WHAT IS CLAIMED IS:

1. A winding module for an electric machine comprising at least one flat winding that is angled at an end turn, wherein a vertex of the angled end turn is aligned with an axis of rotation.

2. A winding module according to claim 1, comprising a plurality of stacked, flat windings, each of said windings angled at an end turn, wherein vertices of the angled end turns are aligned to be coplanar with said axis of rotation..

3. A winding module according to claim 2, further comprising blocks disposed between the windings.

4. A winding module according to claim 1, wherein the flat winding is comprised of one of a group consisting of copper windings and superconductive windings.

5. An electric machine comprising:

a rotor body defining pole faces and having parallel sides perpendicular to the pole faces;

a winding module fitted over the parallel sides of the rotor body, the winding module including at least one flat winding that is angled at an end turn, wherein a vertex of the angled end turn is aligned with an axis of rotation; and

a pair of spindles secured to respective ends of the rotor body, the spindles securing ends of the winding module to the rotor body.

6. An electric machine according to claim 5, wherein the winding module comprises a plurality of stacked, flat windings each of said windings angled at an end turn, wherein vertices of the angled end turns are aligned to be coplanar with said axis of rotation.

7. An electric machine according to claim 6, wherein the winding module further comprises blocks disposed between the windings and the rotor body.

8. An electric machine according to claim 7, further comprising a spring disposed between each outermost one of the blocks, respectively, and each one of the spindles, respectively.

9. A rotor winding module for electric machine fields comprising at least one flat winding shaped to include a preloaded axial offset that allows end arms of said winding to lengthen and shorten with changes in rotor speed without undergoing elongation.

EXPANDABLE FLAT WINDING FOR ROTATING ELECTRIC MACHINE FIELDS

ABSTRACT OF THE DISCLOSURE

A winding module for a rotating electric machine includes at least one flat winding carried on the rotor body and angled at an end turn. A vertex of the angled end turn is aligned with the rotor axis of rotation. The so-shaped flat winding of the winding module provides a preloaded axial offset that allows end arms of the winding to lengthen and shorten with changes in a rotor speed, without suffering elongation.

FIG.1

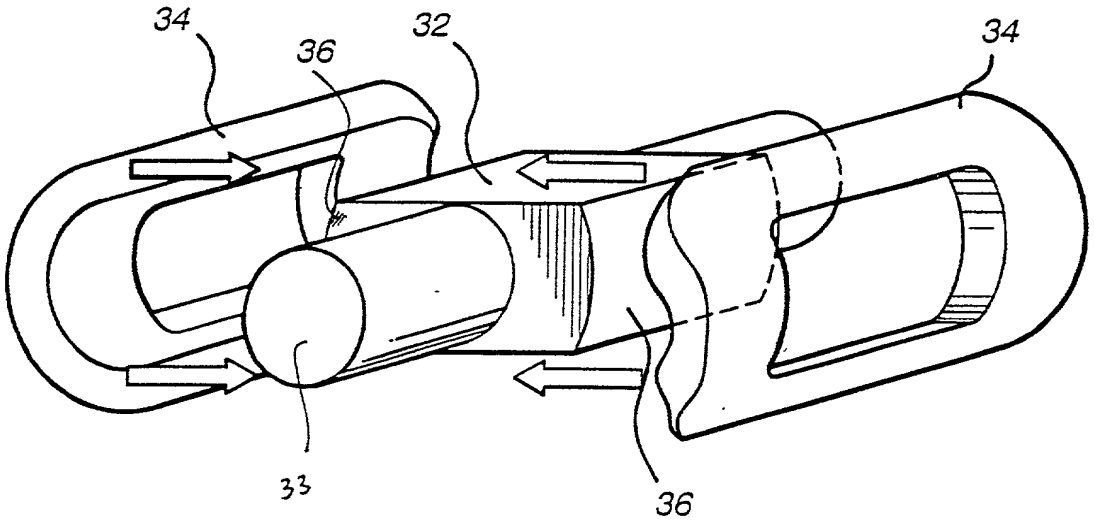
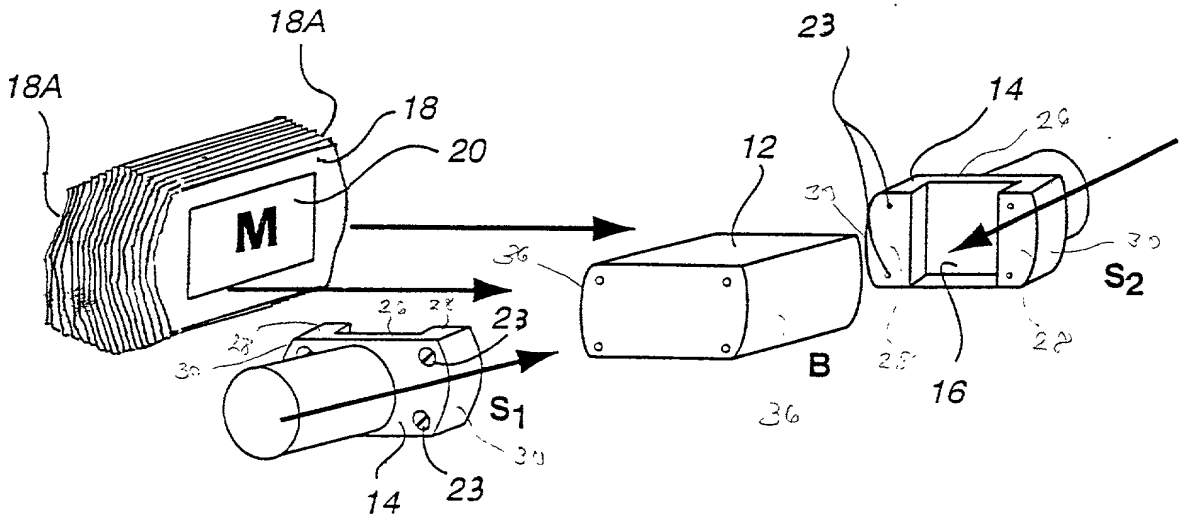


FIG. 4



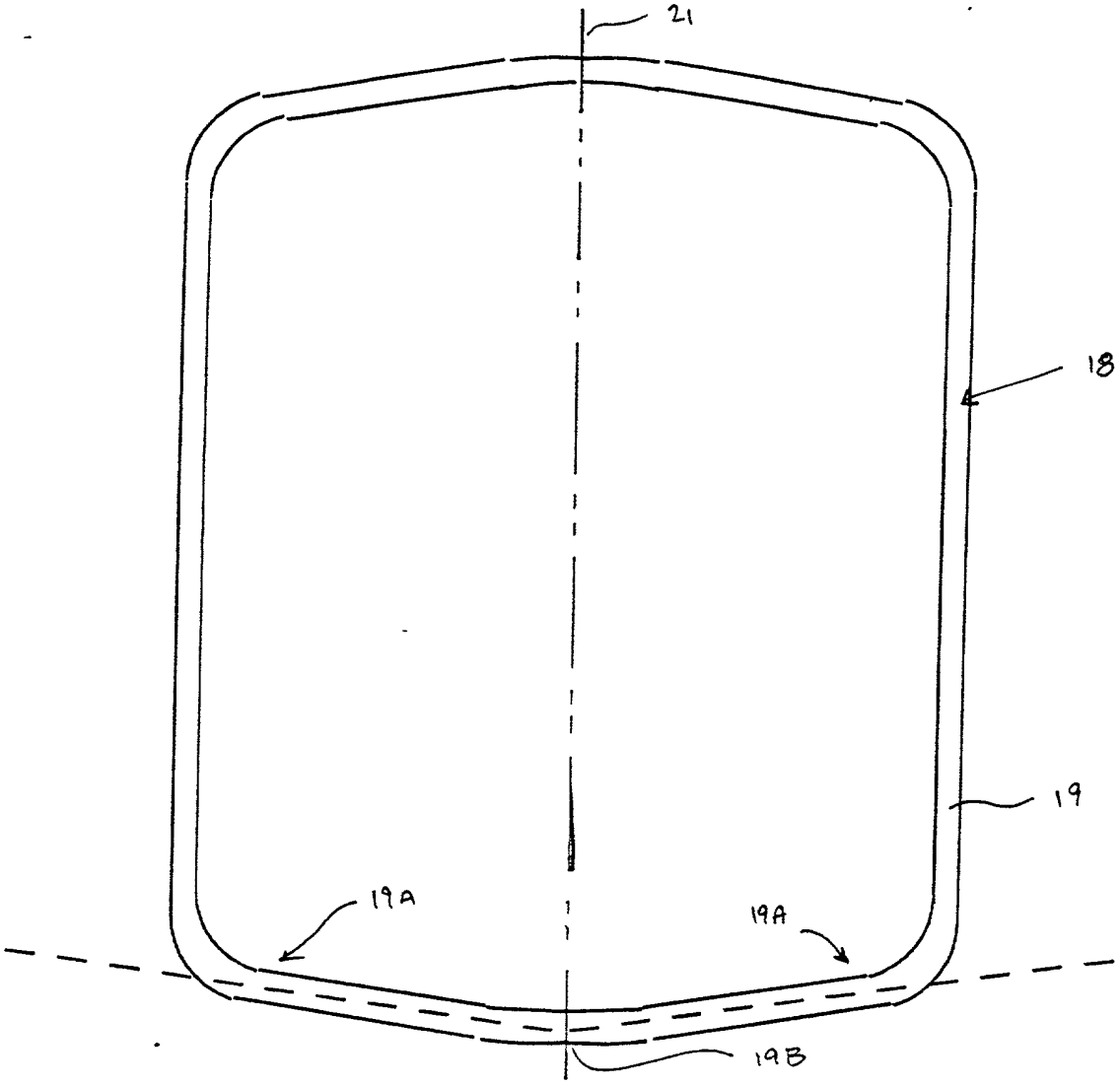


FIG. 2

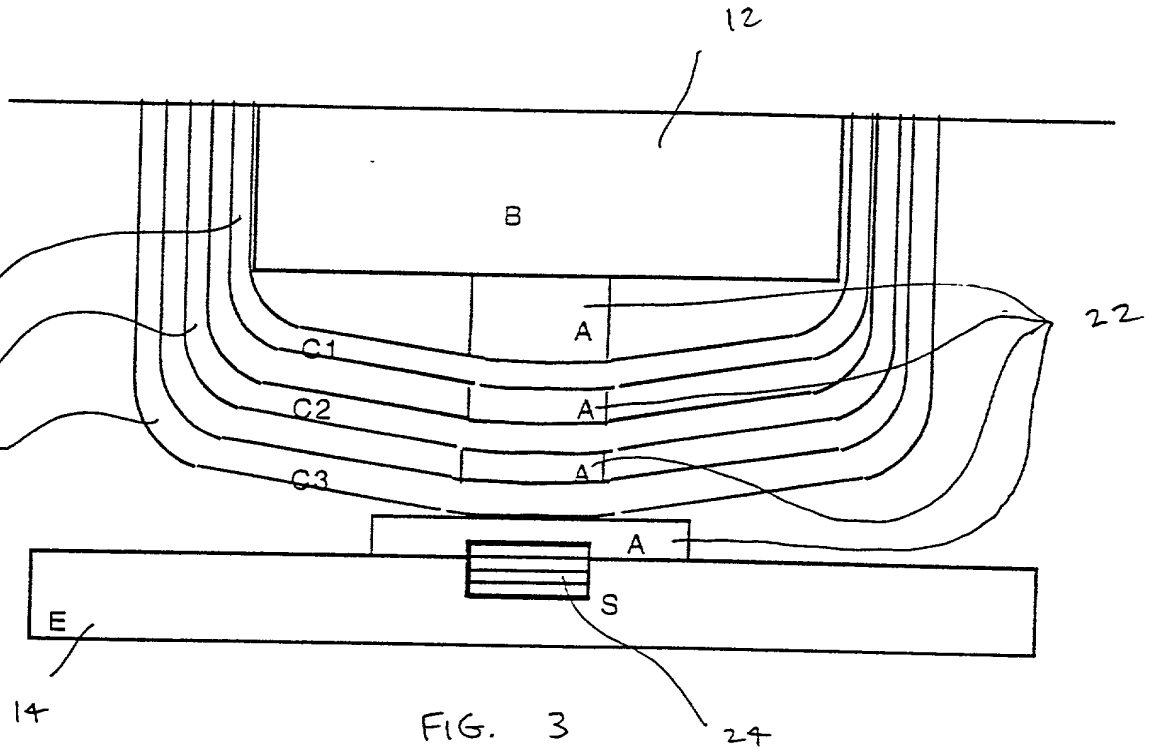


FIG. 3

DECLARATION FOR PATENT APPLICATION

Docket Number
RD-27,502/USA

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

EXPANDABLE FLAT WINDING FOR ROTATING ELECTRIC MACHINE FIELDS

the specification of which is attached hereto unless the following box is checked:

☐ was filed on _____ as United States Application Number or PCT International Application Number _____
and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations §1.56. I hereby claim foreign priority benefits under Title 35, United States Code, §119(a)-(d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed.

Prior **Foreign Application**

(Number)	(Country)	(Day/Month/Year Filed)	Priority Claimed
			☐ Yes ☐ No
			☐ Yes ☐ No

I hereby claim the benefit under Title 35, United States Code, §119(e) of any **United States provisional application(s)** listed below.

(Application Number)	(Filing Date)
60/169,242	12/06/99

I hereby claim the benefit under Title 35, United States Code §120 of any **United States Application(s)** listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

(Application Number)	(Filing Date)	(Status - patented, pending, abandoned)

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith, **CUSTOMER NO. 006147.**

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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